A STUDY OF THE CARYODIDAE (PULMONATA) PART 1.
Anoglypta launcestonensis (Reeve 1853)

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ABSTRACT

The Tasmanian terrestrial snail *Anoglypta launcestonensis* (Reeve 1853) is redescribed and a lectotype erected. A diagnosis of *Anoglypta* Martens, 1861 is provided and its distribution defined.

INTRODUCTION

Limited in habitat to rain and mixed forests of north east Tasmania the endemic mollusc *Anoglypta launcestonensis* (Reeve 1853) is considered to be an endangered species (Wells *et al.*, 1983). Research so far, in attempting to assess the degree of threat, has aimed at recognising the type locality, type material and the extent of distribution.

A proposed type locality which recognises the source of the original material has been defined (Kershaw 1987). This paper erects a lectotype and provides a new description based on specimens from this type locality. Recent collections have enabled revision of the distribution with comparisons between the more or less isolated populations. A study of several Caryodidae species has allowed an improved understanding of this Australian endemic family. A more advanced study is proposed (H.P. Morton pers. comm).

This species is readily recognised due to the distinctive shell. Petterd (1879) recognised a "normal character", however a degree of variation can now be recognised.

TAXONOMY

Pilsbry (1894) described *Anoglypta* Martens, 1861 as "most peculiar" and "unique" due to his perception of the shell sculpture and a "backward-projecting sack on the spermatheca duct". Iredale (1937) impressed with the shell introduced Anoglyptidae but Zilch (1960) preferred Caryodinae. Recent authors (e.g. Smith & Kershaw 1981) prefer Caryodidae.

A study of chromosome numbers and some anatomical data by Dartnall & Dartnall (1972) clearly demonstrates the relationship with *Caryodes* Albers, 1850. These authors find a greater degree of distinction between the two Tasmanian genera compared to the mainland genera *Pedinogyra*, *Pygmipanda* and *Hedleyella*. Early studies by Hedley (1891, 1892) recognise a relationship between all these genera. Hedley also suggested that the *Anoglypta* shell sculpture should be regarded as ancestral.

The Caryodidae are derived from a Gondwana lingeage now apparently correctly placed in the Sigmurethra, Acavacea (Solem 1978).

MATERIAL AND METHODS

The proposed lectotype is based on a shell in the British Museum (Natural History). Voucher specimens of shells with animals from the type locality are lodged in the Tasmanian Museum (TM), the Museum of Victoria (NMV), the Australian Museum (AM) and the Queen Victoria Museum and Art Gallery (QVM). All the other material studied, including dissected specimens, has been placed in the Queen Victoria Museum and Art Gallery.

Grid references provided refer to the 1:100,000 Topographic Survey, Tasmania Sheets 8315 (Pipers), 8415 (Forester) and 8518 (Georges Bay). The distribution map (fig. 34) is based on the 1:500,000 State Map by courtesy of Tasmap.

The study is based on ten dissections and a series of 137 shells from 28 localities (Table 1). Scanning electron micrographs of the radula are by Adrian Daniell of La Trobe University. Part two of this study deals with *Caryodes dufresnii* (Leach) and further parts are in preparation.

Anoglypta Von Martens 1861

Haplotype *Helix launcestonensis* Reeve 1853

DIAGNOSIS

Shell: (Fig. 2). The spire is conoid, dull coloured, the periphery acutely keeled, the base convex, dark glossy, with a distinct band and deep umbilicus. The sculpture, orginating on the protoconch is strongly spiral cut radially into distinct bold elongate granules but becomes microscopic on the base. The aperture rotates from vertical in the juvenile to almost horizontal in the adult.

Animal: (fig. 1). A variably coloured snail of the Caryodidae with elongate unicuspid teeth mounted on short broad basal plates. The penis and vas deferens are tightly more or less entwined, the vas deferens immersing in the penial wall tissue at least 5mm from the male pore following a very brief epiphallic swelling but having no verge or penial sheath. The male pore is a simple orifice lined with minute raised rounded pustules just visible externally when the penis is fully everted. The very short free oviduct is lined with fine laminate ridges entering the vagina. A small bursa duct diverticulum with distinct internal structure has its apex, adjacent the free oviduct pore, directed toward the atrium. The carrefour region apparently of simplified structure has the hermaphrodite duct entering a barely hooked talon not embedded in the albumin gland but receiving the albumin duct at the spermoviduct junction.

DISCUSSION

A description of *Anoglypta* is given by Pilsbry (1894) who found the ovotestis to be "composed of a very long series of irregular clusters of fine follicles, embedded in the liver". He describes the diverticulum (present in all the caryodids) as "the blind sack of (the) spermatheca duct".

The most obvious difference between *Anoglypta* and the related genera is observed in the strongly sculptured depressed shell. The eastern Australian *Pedinogyra* has a depressed discoid shell with very weak sculpture. The anatomy (Pilsbry 1894, Dartnall & Dartnall 1972) differs noticeably in the presence of an elongate diverticulum. The ovotestis is embedded in the digestive gland but the penis, which has a distinct epiphallic region, clearly resembles *Hedleyella* and *Pygmipanda*.

Anoglypta is also separable from other members of the family on the basis of the chromosome number (Dartnall & Dartnall 1972), the reversed diverticulum and the shell.

SUPRAGENERIC FEATURES

The Caryodidae all have two important features in common. There is a diverticulum having its pore in the vicinity of the junction between the vagina and the bursa duct. The vagina is functional in receiving the penis during copulation. The expanding pore of the bursa duct receives the tip of the penis and ejaculated sperm. Sperm passes into the diverticulum as well as the bursa duct.

Secondly the spiral protoconch sculpture continues into the adult shell. This is readily visible on the *Anoglypta* shell. It is almost obsolete in other species and a distinction between protoconch and adult is more evident. Nevertheless the granular pattern due to the radial cuts across the spiral ribs and grooves is microscopically present though degenerate. For example specimens of *Pedinogyra* may have evidence of this sculpture present only near the periphery and in the umbilicus.

The basal sculpture of the *Anoglypta* shell has degenerated in the same manner. It may be almost completely absent or at best weakly visible. Radial almost nodular ridges developed

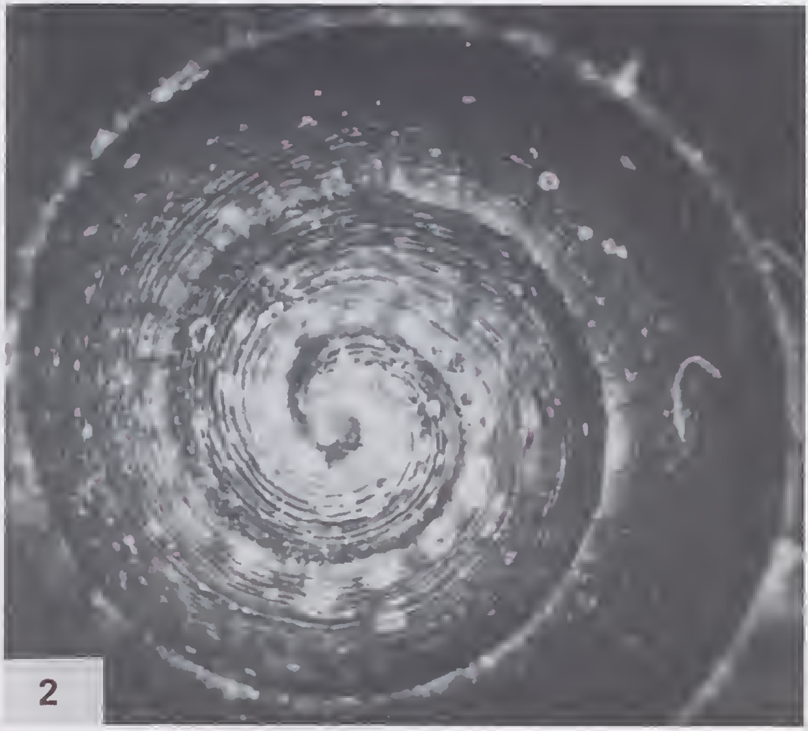

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Figure 2. Protoconch. The change to adult at 2.25 whorls, 6.5mm diameter, is in the upper left.

Figure 3. Shell base and maturing aperture. Diameter 27mm.

on the protoconch are present in *Caryodes* and *Anoglypta*. These ridges are degenerate in the adult shell but are present below the sutures although almost absent in *Hedleyella*. Germain (1925) has described various features of related families and genera.

Anoglypta launcestonensis (Reeve 1853)

Lectotype: British Museum (Natural History) Registered Number BM 1963865; one shell of dimensions 22.3mm height, 29.4mm diameter.

Voucher Specimens: E 17227 (TM), animal with shell of dimensions 5.25 whorls, 21.4mm height, 28.1mm diameter; C153596 (AM), animal with shell of dimensions 5.25 whorls, 20.9mm height, 28mm diameter; F53269 (NMV), animal with shell of dimensions 4.625 whorls, 17.4mm height, 25.5mm diameter; QVM 1987/9/2 dissected animal with shell of dimensions 5.5 whorls, 24.4mm height, 34.8mm diameter; all from within the type locality.

Type Locality: "Launceston, Van Diemen's Land"..."collected last summer by Mr. Ronald Gunn in a dense beech forest, north-east of Launceston." (Reeve 1853b) now defined as that area bounded by 41°15-S to 41°21-S and 147°31-E to 147°40-E (Kershaw 1987).

THE SHELL

Diagnosis: As for the genus.

Description

The Protoconch (fig. 2) is slightly obtusely raised and varies from 2.25 to 2.33 variably coloured whorls ending at a distinctly depressed radial groove. The peripheral sculpture consists of three bold sub-rounded spiral ribs one of which is distinctly broader. There are five riblets below and three above on the steep slope into the nucleus. The sculpture develops in increments within which the rib number increases with growth to develop progressively into the adult sculpture. Radial grooves cut spiral ribs into elongate granules. These beads are raised and ridges develop with the widening whorl of the adult.

The Adult sculpture (fig. 5) consists of several bold spiral ribs cut into short granules. Above the keel and on each side of the sutures there are two closely spaced ribs. Several spiral granular lirae occur between the ribs. Radial ridges, boldest below the sutures radiate across each whorl to the periphery. Faint traces of the spire sculpture are usually present on the convex base (fig. 3) and pass into the umbilicus.

The Umbilicus (fig. 3) is steeply funnel shaped, somewhat angled at its entrance with a fine spiral groove descending within. The diameter ranges from 16% to 27% of the adult diameter with an approximate mean of 25%.

The Aperture (fig. 3, 4) is almost rectangular in the juvenile with a vertical columellar margin. A diamond shape develops as the columella becomes progressively more oblique, then in the adult, elongate ovoid with thickening lips and a reflection at the columella. Peripheral growth is more rapid than basal in maturity and the whorl curves sharply downward rotating the aperture towards horizontal. A distorted distinctly raised area develops at the point of change in pattern. Growth pressure against the rigid basal margin over the last 15mm, distorts the upper margin into a sinus above the keel. The aperture becomes smaller in dimensions with a loss of 2 to 4mm in height as an ovoid gerontic shape develops. The maturation process begins at about 5.5 whorls and continues until 5.75 whorls. Shells of 6 whorls appear to be rare.

THE ANIMAL

The Foot (fig. 1) of about 45mm length varies in colour from cream to brown with a pale sole.

The Jaw (Fig. 9) is arcuate with a barely noticeable median projection in some instances. It is subtriangular in cross section, pale orange with a dark orange antero-ventral edge and sculptured with close transverse grooves and ridges crossed by a subcentral longitudinal groove.

The Radula (figs. 26-33) consists of 170 rows of unicuspid elongate broadly convex teeth set on strong columns arising anteriorly from short broad basal plates. The formula is approximately 41.9.1.9.41. The elongate triangular central tooth (fig. 27) has shallow depressions

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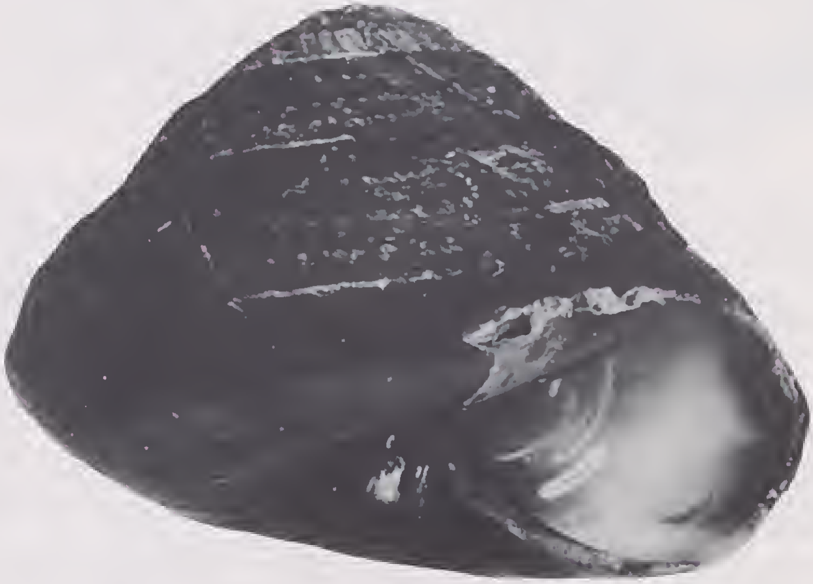

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Figure 4. Spire profile with keel and subadult aperture. Shell diameter 28mm.
Figure 5. Spire showing sculpture detail. Shell diameter 29mm.

adjacent a slightly raised flange. It is pointed posteriorly, slightly curved but variable and may resemble an hour-glass.

The Lateral teeth (fig. 28, 33) are broader more elongate with distinct anterior depressions, a distinctly raised flange and in some cases a clear raised ridge separates the depressions. At least 9 laterals are recognizable. From tooth 10 there is a tendency for teeth to be angled toward the centre.

The Transitional teeth are slightly longer then clearly longer through teeth 18 to 22. Subsequent marginals are shorter and broader as noted by Pilsbry (1894).

Cusp Wear: (fig 29, 30) Obvious rounding of cusps, particularly with age, is evident. Petterd (1879) who first provided a tooth formula, described the teeth as bluntly rounded. Chipping and fracture are evident in the outer marginals. Variable erosion obscures the difference between lateral and marginal teeth. Maximum wear is central to about tooth 8 on each side and in outer marginals from about tooth 24 (fig. 31).

The soils of the habitat are gritty to very stony, the 'A' horizon on granite in particular having a high level of fine quartz gravel. Of animals found on moss one at least appeared to be grazing. However, nothing is known of behaviour or diet.

Basal Plates: The plates are broadest below the supporting column, narrower posteriorly and rounded laterally in a distinct rounded ridge. Each plate interlocks with its anterior and posterior neighbour (figs. 30, 32, 33) with a projection and socket device (Pilsbry 1894). Solem (1972) has noted the added cutting power.

Remarks:

The broad cusps are similar to those present in other caryodids. The central tooth in *Caryodes* has a very distinctly raised anterior ridge. The anterior flange present in the *Anoglypta* laterals is clearly raised compared to the shorter laterals of *Caryodes*. The basal plates are similar in these animals.

Mead (1986) points out that the basal plates of the early laterals of the Caryodidae are shorter than those of the Acavidae. In the acavid genera *Stylodon* and *Leucotaenius* there are reduced ectocones present. The broad central and lateral mesocones of the acavids are similar to those of the caryodids but otherwise and resemblance is much less obvious.

Anatomy

The foot cavity (fig. 6) contains the terminal genitalia, the elongate buccal mass, the thin tubular anterior oesophagus, a grey coloured salivary gland (fig 10), the circumoesophageal ganglionic ring and the anterior musculature. Very fine salivary ducts are seen on each side of the pharynx anterior to the cerebral ganglia.

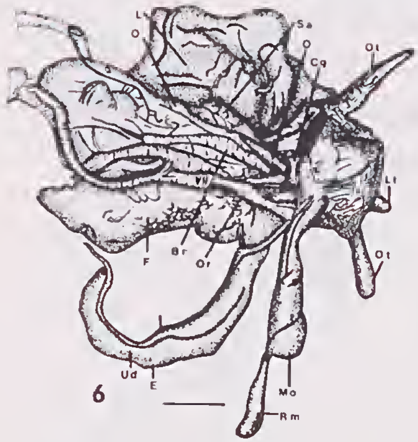
The digestive system is elongate, the grey coloured stomach bulging abruptly within the visceral mass (fig. 7) anterior to the albumen gland. Masses of fat accumulate dorsally in this region.

Pallial Organs

The Pallial region is very elongate with a strongly developed circulatory system (fig. 8). The Heart (fig. 11), situated adjacent the apical kidney is contained within a narrow flexible pericardium (fig. 8). The ventricle is elongate, broad apically with the aorta branching almost immediately. The cephalic artery rests in the foot cavity immediately below the cerebral commissure (fig. 24).

The Kidney (fig. 8) is elongate, subtriangular to almost subcylindrical usually covered with a dense capillary network. Internally it is heavily lined in a reticulate pattern (fig. 12). The distinct primary ureter (fig. 8) opens at the base of the kidney into the pallial cavity adjacent the rectum. No secondary ureter is visible.

The Digestive Gland (fig. 7) is pale reddish brown or brown. The Rectum (fig. 8, 18) develops laminate internal ridges at the anus.



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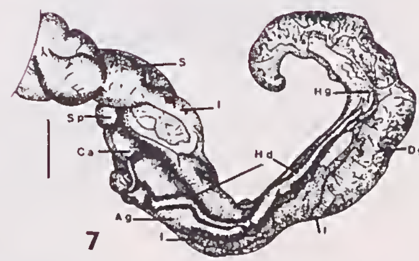

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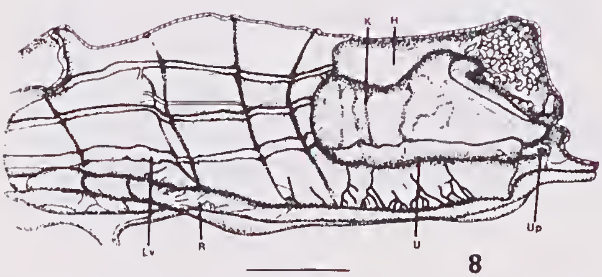

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Figure 6. Anatomy of the foot cavity and anterior viscera. Genitalia lifted out. Scale 5mm.

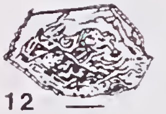
Figure 7. Apical anatomy with stomach (S), albumen glånd (Ag), hermaphrodite duct (Hd), digestive gland (Dg) visible. Scale 5mm.

Figure 8. Pallial anatomy with venation, kidney (K) and pericardium (H) visible. Scale 5mm.

Figure 9. Jaw. Scale 1mm.

Figure 10. The buccal mass (Bm), Anterior oesophagus (O) and salivary gland (Sa). Scale 5mm.

Figure 11. The heart — auricle (Au), ventricle (Ve) and aorta (Ao). Scale 2mm.



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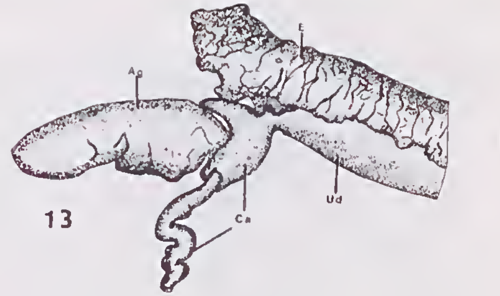

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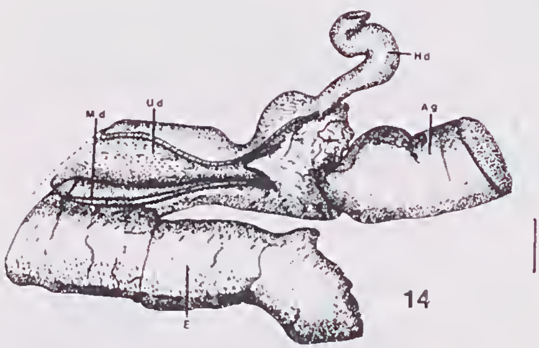

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Figure 12. Internal kidney structure. Scale 2mm.

Figure 13. Apical genitalia: albumen gland (Ag), carrefour region (Ca), hermaphrodite duct (Hd) shown. Scale 1mm.

Figure 14. Apical genitalia: carrefour (Ca), oviduct (Ud), male duct (Md) and extended prostate. Scale 1mm.

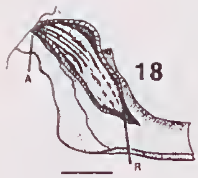
REPRODUCTIVE ANATOMY

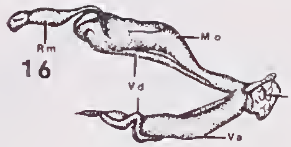
Apical Genitalia: (fig. 7). The ovotestis consists of irregular clusters of fine follicles (Pilsbry 1894) embedded on the inner surface of the digestive gland within the second and third whorls. The very elongate hermaphrodite duct (fig. 7) which coils and kinks with sexual maturity, rests against the albumin gland but is not embedded (fig. 13). The undeveloped albumin gland is small, digitiform, cream coloured and becomes blocky with development. In the carrefour region the hermaphrodite duct enters a slightly hooked bulging (0.6mm by 0.7mm) talon which, so far as studied (fig. 14) enters a simple chamber about 1.5mm long, receiving the albumin gland duct. This inflated chamber is situated between the gland and the common duct which junctions through a narrow neck. The animal is in male phase as witness the extended development of the prostate.

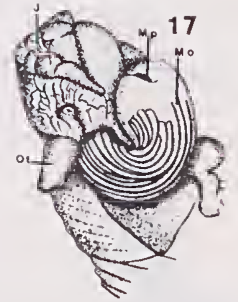
The Spermoviduct

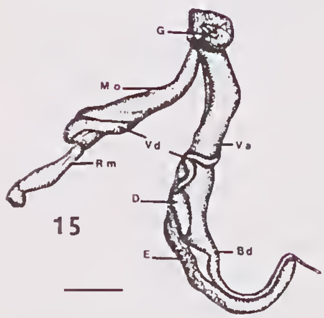
The Common duct (fig. 14, 15) is elongate and narrow consisting of the capacious flatly narrowed pale cream coloured uterus with the sperm duct bulging into the lumen. The mature deep cream prostate, laterally adherent bulges out from the sperm duct. The oviduct enters the vagina from a very short free oviduct.

The Bursa Copulatrix is a globular body situated between the stomach, digestive gland and the basal kidney (fig. 7) where it is sometimes deeply impressed. The bursa duct is narrowly elongate and adherent to the common duct for most of its length to the apical vagina (fig. 15). At the junction (figs. 20, 22) the duct pore expands trumpet-like and the internal structure









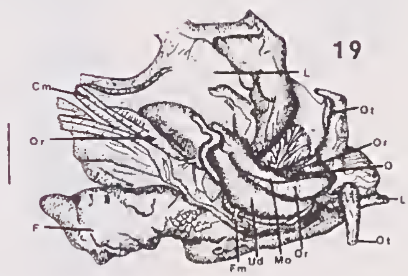


Figure 15. Genitalia-coiled penis (Mo), vagina (Va) and diverticulum (D); Maurice Rd animal. Scale 5mm.

Figure 16. Genitalia with penis uncoiled revealing vas deferens (Vd) and retractor (Rm); Maurice Rd. animal. Scale 5mm.

Figure 17. The extruded penis structure. Scale 2mm.

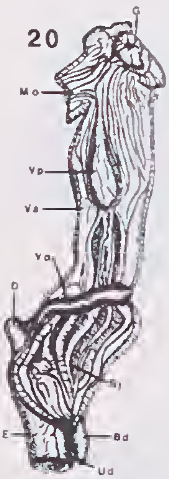
Figure 18. Internal rectum at the anus. Scale 2mm.

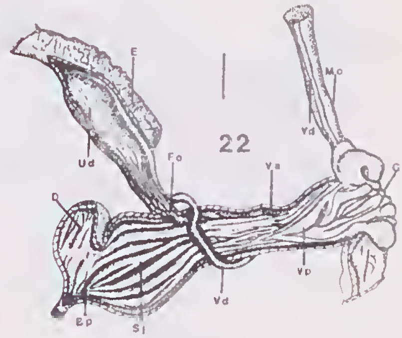
Figure 19. Terminal genitalia in situ; Maurice Rd animal showing musculature. Scale 5mm.

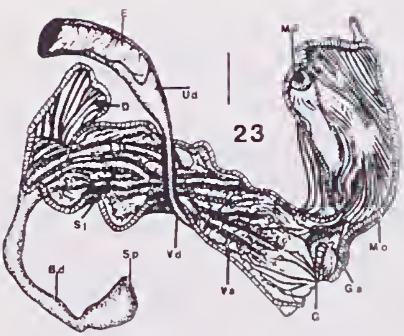
of thin ridges expands to bold pilasters apparently continuous with the vagina structure. A change occurs near the free oviduct pore region where the apical vagina and bursa duct structure merge. Functionally the expanded bursa duct pore is continuous with the apical vagina and receives the penis.

The Bursa Duct Diverticulum (fig. 15) is a small narrow sac tightly adherent to the junction wall with the apex adjacent the free oviduct. Internally the narrow pore opens to the bursa duct at the point of change between the duct and junction structure. The distinct diverticulum structure consists of low wide pilasters with narrow interstices (Maurice Rd. site, fig. 20), variably impressed interstices (South Barrow site, fig. 22) or numerous narrow pilasters with shallow interstices (Mt. Barrow site, fig. 23).

The Vagina (fig. 20) is an elongate narrowly inflated chamber receiving the free oviduct apically. The free oviduct, lined with very fine laminate ridges, enters the vagina through a very narrow pore (fig. 22). From the point of bifurcation from the vas deferens it is no more than 2mm long. The vagina lumen is lined with bold pilasters of varying complexity. Centrally the pilasters are narrow and joined across the interstices by microscopically thin ridges. Basally the structure is dominated by a large broad pilaster with narrow low pilasters adjacent. Apically







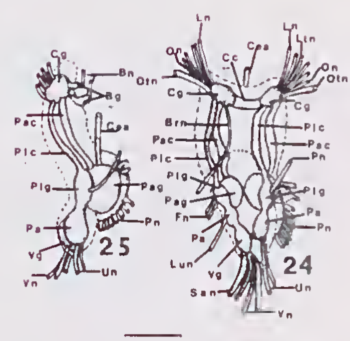


Figure 20. Vagina structure, Maurice Rd. animal. Scale 2mm.
Figure 21. Penis structure, Maurice Rd. animal. Scale 2mm.
Figure 22. Vagina structure, Sth. Barrow animal. Scale 2mm.
Figure 23. Vagina and penis structure, Mt. Barrow animal. Scale 2mm.
Figure 24. Central nervous system, dorsal view. Scale 2mm.
Figure 25. Central nervous system, lateral view from the right side. Scale 2mm.

the junction of the vagina and expanded bursa duct is lined with bold variably transversely slit pilasters with deep interstices crossed by microscopic ridges.

The Atrium (figs. 21-23) is short, 3 to 4 mm deep, lined with wide flattened pilasters divided variably into vaginal and penial components. The external gonopore (fig. 22) may involve conspicuous bulging lips with male and female openings adjacent or (fig. 21) with the vagina opening internal.

Male Genitalia

The right ocular tentacle passes over the penis and the tentacle and optic nerves pass on each side of the penis.

The Vas Deferens (fig. 15) is an elongate duct resting conspicuously on the vagina surface (fig. 19). It arises smoothly from the sperm duct (fig. 22) emerging beyond the prostate extremity to separate from the oviduct adjacent the vagina. It is bound to the penial surface with strong connective tissue and coils with the penis (fig. 15) in the type locality animal. It enters the penial wall at least 5mm from the male pore causing the internal wall to bulge typically. The Male Pore (fig. 21) opens from the bulging surface but differs in position possibly on a racial basis.

The Penis (fig. 15, 16) is a variably elongate narrow cylindrical organ more or less coiled. The internal structure (fig. 20) dominated by the bulging vas deferens wall consists of longitudinal more or less broadly laminar pilasters which reduce in number and widen entering the atrium. There is no verge although some forms have a raised complexly ornamented lip to the male pore. The surface of the fully extruded penis (fig. 17) has the internal interstices raised in low rounded ridges and minute pustules are visible at the male pore.

The Penial Retractor (fig. 16) is variably elongate narrow tubular muscle arising from the lung diaphragm near the stomach. It attaches to the penial wall without a caecum subapically opposite the vas deferens pore as noted by Pilsbry (1894).

Remarks:

The retractor is subapical in all the animals dissected and noticeably so in some. It is not strictly terminal as observed by Dartnall & Dartnall (1972) in any of these although it may appear so. In one animal it is immersed with and apparently attached to the upper retractor complex emerging from the foot cavity.

The vas deferens is slightly inflated near the male pore in some animals and may be coloured pink in this region. No other evidence of a distinct epiphallus was observed. Sperm are transferred in mucous strings evidence of which was observed in the mouth of the bursa duct and within the diverticulum. Hedley separated the species on the basis of absence of the diverticulum. As it is small and reversed compared to *Caryodes dufresnii* (Leach) and tightly bound to the surface it could be readily overlooked in some animals.

Pilsbry (1894) considered the diverticulum to be situate on the bursa duct. In this species it opens at the entrance to the narrowed section of the duct and the ornament is distinctive. The vagina-bursa duct junction region also has a distinctive structure.

THE CENTRAL NERVOUS SYSTEM

The very elongate circumoesophageal ganglionic ring is broadly encased in connective tissue (fig. 24, 25). In general the features are those described by Van Mol (1967) and a detailed study is beyond the scope of this work.

The Cerebral Ganglia are ovoid bodies joined by a short commissure within the prominent 2.5mm by 2mm tissue band. The visible nerves radiating from each ganglion include the ocular tentacle, optic, labial tentacle and labial nerves.

The Buccal Ganglia are very small. Situate below each cerebral ganglion they protrude from the ventral surface of the mass. The commissures could not be separated but buccal nerves are clearly visible. Elongate pedal and pleural commissures pass about the oesophagus on each side.

The small Pleural Ganglia are situate closely dorsal to the large Pedal Ganglia. Two nerves are clearly visible from the left pleural ganglion to the left flank. A prominent nerve from the right pleural ganglion passes to the penis where it divides.

The Right Parietal Ganglion is much larger than the left and displaces the visceral ganglion to the left. Nerves pass posteriorly from the right parietal to the common duct and tentacle retractor and from the left parietal to the lung.

The Visceral Ganglion is barely larger than the right parietal. The visceral nerve fan includes a prominent member passing to the salivary gland.

The large globular Pedal Ganglia give rise to 10 or 11 pedal nerves in parallel lines on each side.

Remarks:

The type locality (Maurice Road) animal has the visceral, right parietal and right pleural ganglia all much larger than the left parietal. The left pleural is hard to distinguish. The visceral and right parietal in a Mutual Road animal appear to form one large mass. In the South Barrow animal the ganglia are more easily seen but the visceral and right parietal are very closely associated. The animal figured (fig. 24) from the Weldborough region provided the most readily separable ganglia.

Bargman (1930) placed the Acavidae in her Type VI or Ennea Type. She spoke of the difficulty of dissection in each genus, comments equally applicable to the caryodids.

However, the fusing of the visceral and parietal ganglia observed by Bargman could not be determined and there are other differences compared to *Anoglypta*. The left parietal is apparently not fused, the buccal ganglia are very close to the cerebral and the commissures are very short throughout compared to the cerebral. The resemblance to the Acavidae seems generalised but much closer than to *Arion* (Smith 1967, Van Mol 1967).

Curiously the disposition of the posterior ganglia more closely resembles that in *Victaphanta* (Smith 1970). The left parietal of *Victaphanta* is clearly much smaller than the right. Smith considers the length of the cerebro-pedal and cerebro-pleural commissures to be related to the size of the pharynx which may also be true of *Anoglypta*.

VARIATION

Shell study revealed colour variation which correlates broadly with spire height, animal colour and some anatomy features. This led to recognition of four groups. Group 4 is not supported by anatomy data and there is insufficient detail to delete the possibility of coincidence throughout. However the protoconch sculpture may differ slightly between groups and an interesting distribution pattern has emerged.

Group one is clustered in or near the type locality in the Ringarooma River valley and near Mt. Maurice but there is a similar shell from locality No. 28 (fig. 34). Group two occurs on the higher country of Mt. Arthur and Mt. Barrow and isolated sites at Bells Hill (No. 17) and near Mt. Horror (No. 15). Group three occurs in a small strip of country between Mt. Victoria and Weldborough (Blue Tier) but includes an isolated site at South Barrow (No. 5). Group four includes a small area about Lottah and Goulds Country.

The localities included in the groups are as follows: Group One: Nos. 6, 7 (north), 8?, 9, 10?, 11, 13, 14, 16, 19, 28. Group Two: Nos. 1, 2, 3, 4, 7 (south), 12?, 15, 17. Group Three. Nos. 5, 18, 20, 21?, 23. Group Four. Nos. 25, 26, 27.

Group Definitions

Group One: The dominant shell colour is of reddish brown or brownish red spiral ribs on a light reddish brown surface. The base is dark reddish brown or black with a pale cream or yellowish band. The protoconch of 2.25 to 2.5 whorls of variable colour, has a sculpture of spiral riblets increasing in number with growth and dominated by one conspicuous rib near the periphery. Radial grooves cut the spirals into segments which strengthen with growth. The

adult spire is raised but some very wide specimens have a low height/diameter ratio. A depressed spire may occur in young shells but is very rare among the adults studied.

The animal is pinkish cream, mustard or light brown with a light cream to cream coloured sole. The thick, coiled penis has a short variably thick retractor and is longer than or as long as the vagina. The internal vagina structure is split transversely. The male pore opens upward into the penial lumen in the Maurice animal but toward the apex in Mutual Road animals. (Basis: Four full dissections and several partial.)

Group Two: The dominant shell colour is of dark brown spiral ribs on a light brown or brown surface sometimes with yellow blotches. The base is very dark brown or black with a cream, pale yellow or white band. Ribs may be tinted reddish. The protoconch of 2.25 to 2.3 whorls of variable colour, has a spiral sculpture dominated by one, two or three bold ribs but otherwise resembles Group One. The adult spire is raised.

The animal is cream with a pale lemon or very pale cream coloured sole or brown with a cream sole. The thick uncoiled penis has a very thin elongate retractor and is shorter than the vagina which has the internal structure split transversely. The male pore opens toward the apex as in Mutual Road specimens.

Group Three: The dominant colour is of dark brown spiral ribs on a pale brown or reddish brown surface with greenish brown or greenish black increments. The apex is dominated by yellow or cream. The base is very dark brown, very dark reddish brown or black with a yellowish cream or greenish yellow band. The protoconch of 2.25 to 2.4 whorls of variable colour has a sculpture of broad bold flat spiral ribs cut into irregular blocks following the first whorl. The adult spire is raised.

The animal is mustard or pinkish cream with a cream or brownish cream sole. The thin elongate somewhat twisted penis has a thin elongate retractor and is of similar length to the vagina. The vagina structure of rounded ridges is not split transversely. The male pore opens upward into the penial lumen short of the apex. (Five dissections.)

Group Four: The dominant colour is of horny light brown spiral ribs on a light brown to horny brown surface. The base is tan, light brown or greenish brown with a pale yellow, yellowish cream or greenish light yellow band. The adult spire is distinctly depressed with a low height/diameter ratio. The protoconch sculpture is of 3 to 5 bold subrounded or rounded wide ribs near the periphery, several narrow bold adjacent with narrow riblets between, cut by grooves to form subdued radial ridges. The animal is unknown but the distinctive shells require recognition.

Remarks:

The species was described by Cox (1868) and by Petterd (1879) who repeated Cox's description and added further data. Petterd's rich brown coloured animal seems rare although brown animals occur on the Sideling Range and at Tombstone Creek. A dark tan animal was collected near the Cascade River.

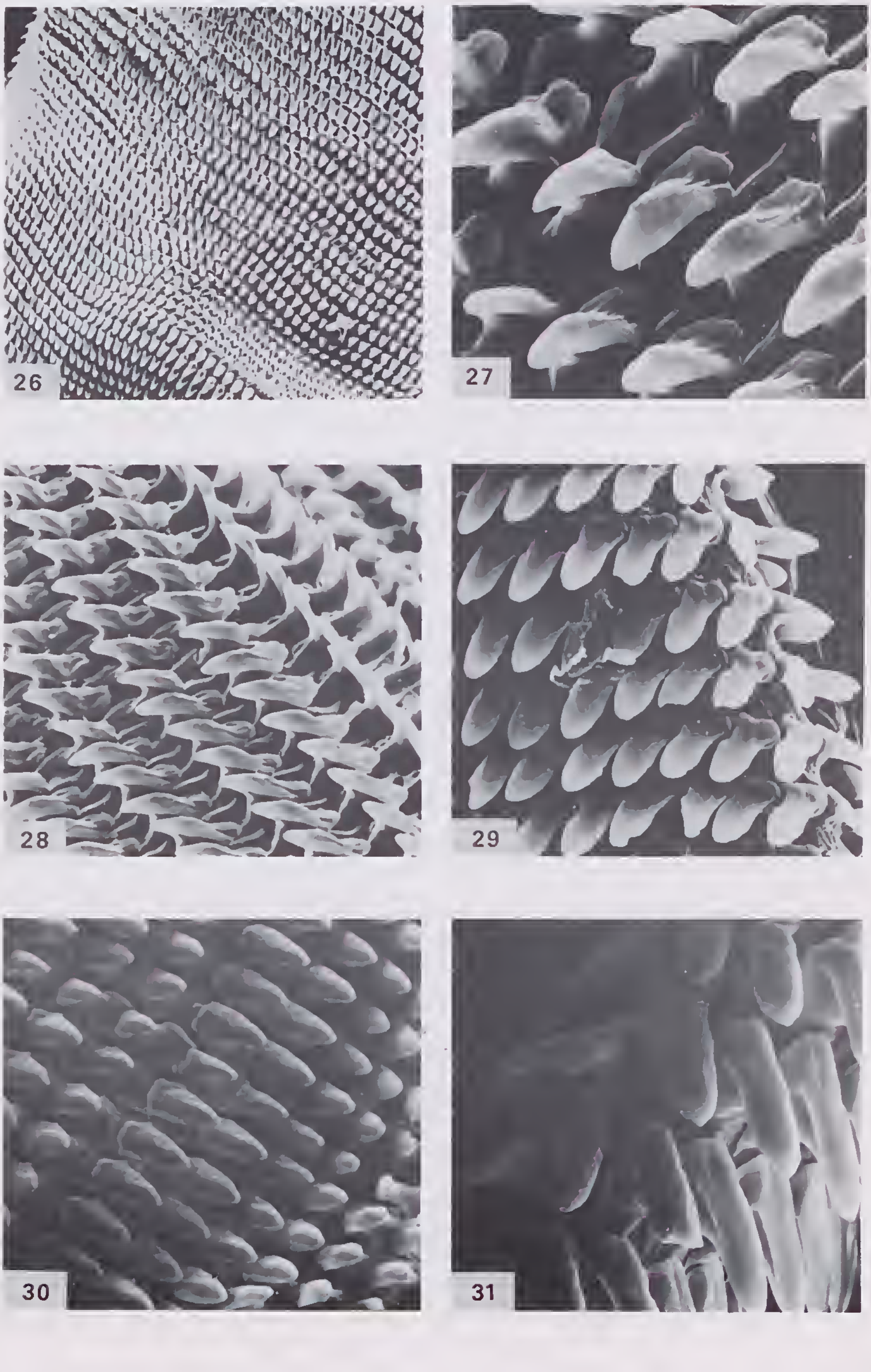
This study is based on 137 shells of which 113 are placed in Group One, 11 in Group Two, 10 in Group Three and 3 in Group Four (Appendix 1). The bias in numbers is due to the large sample from the Mutual Road area. The only other large collection known is the Cox Collection in the Australian Museum but the site from which the material came is unknown.

The anatomical differences are summarised as follows:

Group One: A thick coiled penis approximately equal to the vagina length, with a short variably thick retractor.

Group Two: A thick uncoiled penis shorter than the vagina, with a thin very elongate retractor.

Group Three: A thin elongate penis about equal to the vagina, with a thin elongate retractor. The South Barrow animal has a coiled penis, a long thin retractor and a short vagina. The Weldborough animal has an uncoiled penis, a short thin retractor and a long vagina. The internal structure is the aspect of closest resemblance.


26
27
28
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30
31

Figure 26. Radular teeth × 104. Photography by A. Daniell.
Figure 27. Central and adjacent lateral teeth × 1000.
Figure 28. Central and lateral teeth × 500.
Figure 29. Worn marginal teeth × 520.
Figure 30. Worn central and lateral teeth × 370. Note the interlocking structure.
Figure 31. Marginal teeth × 760. Note the fractured tooth.
Figure 32. Radular teeth in the feeding position × 880. Note the overlap-interlock structure.
Figure 33. Lateral teeth × 740. Note the interlock fit of the support columns with the anterior flange and basal plate of each successive tooth. The cusps point to the posterior.

Maturity: The observed differences could be related to stage of sexual maturity. However of 3 specimens in Group One, 2 were immature and one mature. There is no major difference in these animals. A list of collection dates with genitalia maturity follows:

1. Maurice Road. 5.25 whorls, September, immature.
2. Mutual Road. 5.37 whorls, March, immature.
3. Mutual Road. 5.37 whorls, September, mature.
4. South Barrow. 5.5 whorls, May, mature.
5. Weldborough. 5.25 whorls, December, mature.
6. Weldborough. 5.25 whorls, December, sub-mature.
7. Mt. Barrow. shell not seen, September, mature.

Evidence of copulation was present in the Mt. Barrow animal. The immature animals have the albumen gland small and digitiform but one is in an advanced male phase. Otherwise the prostate and uterus are thin and relatively short. Sexually mature animals have a comparatively large blocky coloured albumin gland with the prostate and uterus expanded and lengthened. Each shell is at a sub'mature growth stage. Mature shells with animals are unusual.

Height/Diameter ratio.

The spire in Group Four shells is lower than average height. One of the four specimens from Lottah-Goulds Country area had average spire height.

Shells of Group One have an expected average spire height. One specimen (among 113) has a lower than average height resulting in a low ratio. Three have a wider than average diameter with a similar result.

Shells of Group Three have one (in 10) of wider than average diameter resulting in a low ratio.

The lack of adequate material does not support effective analysis and a further study is needed. Tables of measurements have been retained.

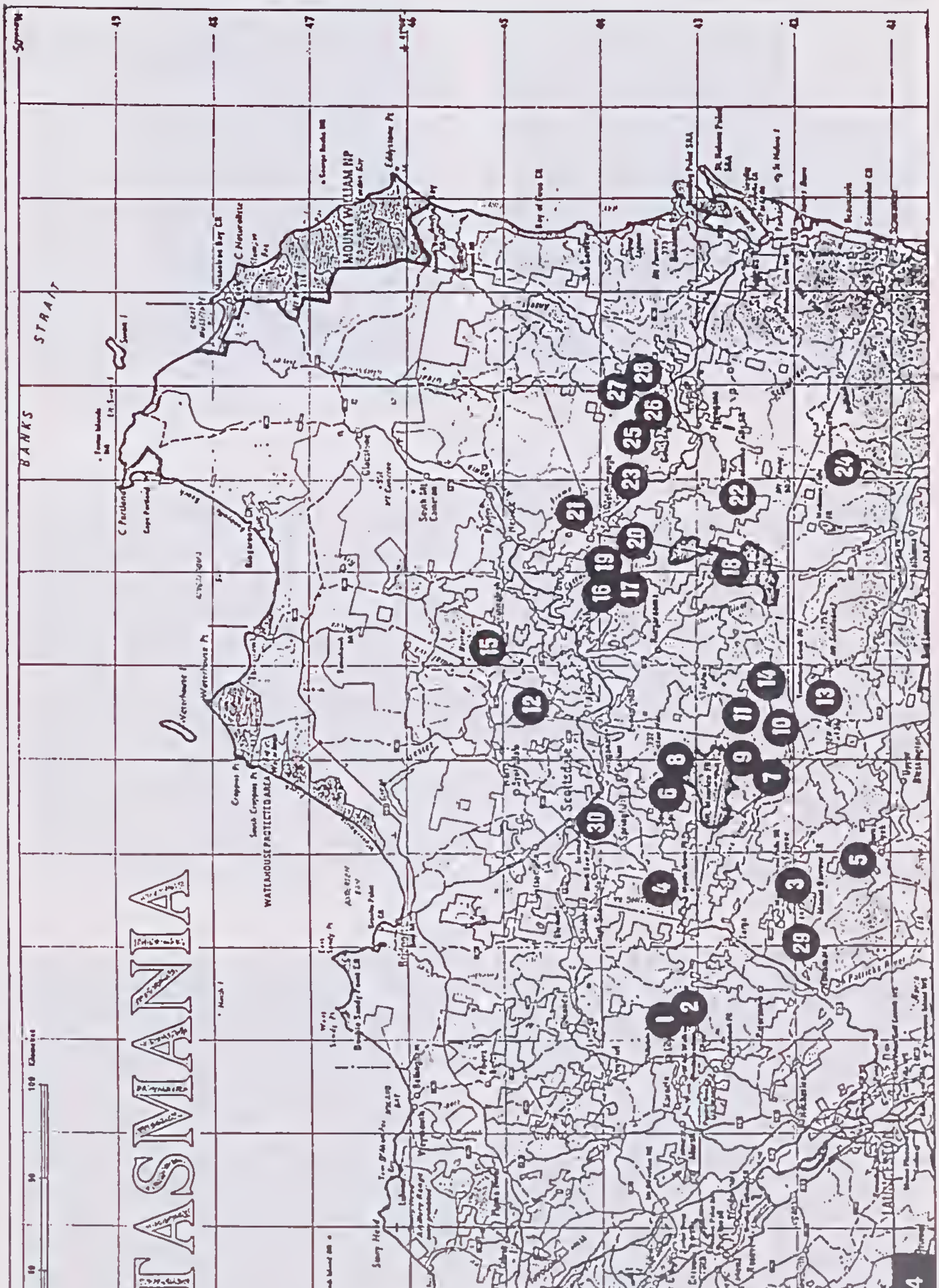

Figure 34. Distribution map of *Anoglypta launcestonensis*. Base map by courtesy of Tasmap.

DISTRIBUTION

Anoglypta launcestonensis (Reeve) is confined to an area of north east Tasmania (fig. 34) between Mt. Arthur to the north from Launceston and forest to the east of Goulds Country (Kershaw 1987). The 30 known localities are listed in Tables One and Two. Intensive field work may reveal more localities within this region but an increase in the distribution pattern seems unlikely. The most northerly records at Kamona (loc. 12) and near Mt. Horror (loc. 15) may be evidence of isolated relict populations which have survived from a past wider distribution. However only dead shells have been found and the status of the populations is uncertain.

This species is regarded as rare and is listed as endangered by Wells *et.al.* (1983). An increase in collecting effort in recent years (table 3) has increased the evidence upon which such opinions can be based. Unfortunately most localities have yielded few specimens and in some, dead shells only. In a State Forest between Cascade Dam and Weldborough (locs. 16-20) fire revealed evidence of a large population. Of more than 130 shells examined about ten contained the remains of burnt animals. It is known that more shells were collected but a number above 200 is unlikely. Population size in Tasmania is not comparable with that of some European species.

Evidence of past good populations has been noted from Mt. Arthur and from Blue Tier. The presence of an existing effective population on Mt. Arthur has not been confirmed. It is thought that past collecting activity and fire may be responsible for a reduction in numbers. The Blue Tier region near Weldborough has long been regarded as an important source of shells. Repeated field trips into the area have failed to reveal more than scattered individuals.

Hence present knowledge, while suggesting a greater level of security than previously believed, still supports an endangered category for the species. Fire has revealed old corroded shells as well as relatively fresh specimens. The life of a shell in these forests in not known but presumably several years accumulation could be expected. The estimate of the distribution provided by Wells *et. al.* (1983) was 3000 hectares. This estimate is here increased to 5000 hectares. An estimated 14000 hectares of suitable habitat may be available but it has not been possible to confirm the presence of the species in such an area. These estimates are based on probability. It must be realised that most finds have been confined to small areas. The localities tabled confirm only the validity of the 3000 hectare estimate. Secondly only one or two specimens have been found at most sites.

Juveniles: Eggs are very hard to find but a few very young animals were seen in the type locality area. In the case of *Caryodes dufresnii (Leach), by no means a very common snail, clutches of 2 to 6 eggs are occasionally found. Populations with several to between 10 and 15 juveniles are found in different parts of Tasmania. On a comparative basis Anoglypta launcestonensis* is very near extinction.

The basic habitat data defined by Kershaw (1987) expands that recognised by Wells *et. al.* (1983). An inspection of the distribution in habitat terms suggests that the best populations known occur on well drained granitic soils in a climate of high rainfall reliability. Among other igneous rocks dolerite is present in small areas such as Mt. Arthur, Mt. Barrow and Mt. Victoria. The areas of basalt are now cultivated. The remaining significant parent material is therefore the micaceous quartzwacke turbidite (McClenaghan & Baillie 1975) sedimentary rocks known as the Mathinna Beds. These beds are important in the *Anoglypta* habitat on the Sideling Range, in the Mt. Horror-Kamona area and to the north of Mt. Victoria.

Habitat Limitations

The habitat includes rainforest and mixed forest (Kershaw 1987). The nature of the habitat requires either high precipitation (say 1400mm per annum) or humid situations such as fern gullies. Most recorded localities are within the 1400mm rainfall isohyet (Bureau of Meteorology 1979). All the remainder except the Mt. Horror-Kamona sites are within the 1200mm isohyet. (The exceptions fall within the 1000mm isohyet and experience a 400mm winter rainfall. It is thought that precipitation reliability may be significant and frequent fogs may be a factor.

The Mt. Horror-Kamona sites are a significant factor against a high rainfall theory. The habitat there includes wet sclerophyll forest with areas of mixed forest. Possibly rainfall records taken within the area may reveal a higher level than existing data indicates. No live animals have been found. The shells from near Mt. Horror (loc. 15) are both damaged. They could have been dropped in the area by birds but could not have been carried far. The Kamona (loc. 12) specimens were revealed by fire. They are old and certainly not transported by birds but may not be part of an existing population. This remains to be confirmed.

The Southern Limit of Distribution.

A second important factor is the apparent absence of the species south of the line between South Barrow (loc. 5) and Evercreach (loc. 24). If the species exists further south relict populations could be expected but there is no known evidence. A close study of the contours reveals that most sites occur above 500m ASL. All the remainder except for Kamona are above 300m ASL. The southern boundary is formed by the old rivers, the South Esk and the North Esk which ultimately flow into the Tamar Estuary at Launceston. With the exception of the headwaters the valleys of these streams are below 300m ASL and occupied by alluvium. They form an important geographic and probably ecologic barrier.

Nevertheless there is a narrow corridor between the upper catchments of these streams formed by Ben Nevis and Roses Tier. This corridor ends abruptly with the steep high face of the Ben Lomond massif. This mountain with its fringe of Pleistocene periglacial tallus may provide a further barrier. Distribution during the Tertiary Epoch was certainly wider than the present. During the Pleistocene the species was confined to sites of surviving rainforest. Present distribution is within regions surrounding the Pleistocene refuge areas. It is unlikely to occur beyond such regions due to a lack of suitable habitat to which it is adapted.

ANOGLYPTA AND THE CARYODIDAE

Anoglypta has a significant place in the family Caryodidae in that it is probably nearest to the common ancestor. The Caryodidae are a closely related group distinguished by the shell sculpture and the proportional uniformity in anatomical features.

The shell sculpture, elaborately developed in *Anoglypta*, could be said to be almost obsolete in the other genera. Nevertheless it is recognizable and was noted by Pilsbry (1890) in *Pedinogyra*, but the comparison he made (Pilsbry 1894) was between *Anoglypta* and the Helices.

Hedley (1892) suggests that *Anoglypta* "may be regarded as most retaining the ancestral sculpture" but his synopsis includes species of *Bothriembryon*. In his opinion the embryonic sculpture ended with the protoconch in all these species but it continues into the adult, although more or less modified, in the caryodids. Coarse radial ridges which originate on the protoconch and are most obvious below the sutures can be seen there in Hedley's drawing of *Panda atomata*. They are distinct in *Caryodes* and *Anoglypta* (fig. 2) but hard to see in *Pedinogyra*. The *Bothriembryon* protoconch is very different (see e.g. Kershaw 1986). Pilsbry (1890) stated clearly that the embryonic whorls "are not different from the adult" in *Panda* (i.e. *Hedleyella*).

THE DIVERTICULUM

The anatomy of the caryodids is fundamentally closely similar. Each known species has a more or less elongate pallial structure, no secondary ureter, similar genital structure with an "appendicula" (Pilsbry 1894, Dartnall & Dartnall 1972). This sac is adherent to various parts of the spermoviduct wall at or near the bursa duct-vagina junction. Although it is small and reversed in *Anoglypta* it is basically the same structure.

While retaining some ancestral features *Anoglypta* appears to have become increasingly specialised. It is possible that the diverticulum has a reduced function. In other caryodid species during evolution of the elongate form and enlarging shell, the diverticulum has shifted, lengthened, more or less coiled with the common duct and changed in orientation. Some

morphs of *Caryodes* also have a very small diverticulum but the question of the function of this organ is not within the scope of this work.

Two groups have evolved, a discoid *(Anoglypta, Pedinogyra)* and a bulimoid *(Caryodes, Pygmipanda,* etc.). It is suggested that the populations were isolated and evolved in parallel hence retaining considerable similarity. Confined to the ancient forests *Anoglypta* evolved very slowly. The adaptable *Caryodes* has evolved a bulimoid form independently of the mainland caryodids. Although the *Pedinogyra* form is depressed discoid, its anatomical resemblance to the mainland bulimoid species confirms that it evolved from that stock.

FOSSIL EVIDENCE

The species *Helix simsoniana* Johnston 1881 was described from calcareous beds of the Kent Group. Johnston (1881) thought the beds to be of Tertiary age but saw a similarity to the Furneaux Group Helicidae Sandstone. The late Edmund Gill (*in litt.* 1986) suggested that the evidence supports a Pleistocene age.

Johnston noticed a resemblance with *Helix launcestonensis* at first but later added a note suggesting a link with *Helix greenwoodi*, a New Zealand rhytidid. *H. simsoniana* has two keels as has *Rhytida duplicata* Suter but Johnston's figure shows the second keel well above the periphery. However a fossil in the Simson Collection, Queen Victoria Museum and Art Gallery QVM:1987:G:162, labelled *Helix simsoniana* apparently by Simson, has a peripheral keel, a close supra-peripheral keel, a depressed spire and more than four whorls.

A second specimen, QVM:87:G:163, labelled *Helix* sp., a fossil from the Kents Group, Bass Strait, is much larger at 3.75 whorls with one peripheral keel. Neither resembles *Anoglypta* thus supporting the second opinion but Johnston refers to an irregular cancellated basal surface and a broad shallow apertural sinus. A close inspection of the fossils reveals the remains of oblique radial ridges on the protoconch which are coarser on the adult whorls of the larger fossil. There are also radial and spiral alignment traces on the body whorl and adjacent the umbilicus with radial alignments entering. This specimen has some resemblance to the living *Pedinogyra*. In the Salisbury Collection National Museums of Scotland (NMSZ 1961) there is another example which differs from *Helix simsoniana* in having only one keel.

The specimen QVM:87:G·163 differs also in the larger diameter at fewer whorls. Compared to *Pedinogyra* it has a raised spire and narrower umbilicus but it is not mature. This may be an unnamed species apparently much closer to *Pedinogyra* than any other form seen. As so few specimens have been seen further investigation is required to determine the validity of the sculptural remains, apparent resemblances and the age of the beds.

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TABLE 1

List of Localities for Material Studied

No.	Locality	Grid Reference	Collector	Group
1.	Mt. Arthur	.523300E.5432900N.	14	. 2 .
2.	Mt. Arthur	.525550E.5430900N.	9	. 2 .
3.	Mt. Barrow	.535600E.5420100N.	10	. 2 .

3.	Mt. Barrow	.535800E.5420100N.	24	2
4.	Sideling Range	.535700E.5433050N.	18	2
5.	South Barrow	.538400E.5415600N.	23	3
6.	Mackenzie Rivulet	.546050E.5433150N.	15	1
7.	Russells Road	.547950E.5422425N.	15	1
7.	Wombat Plain	.548300E.5422400N.	13	2
9.	Maurice Road	.550300E.5424000N.	15	1
9.	Maurice Road	.552450E.5425300N.	11	1
11.	Maurice Road	.554700E.5426000N.	11	1
13.	Tombstone Creek	.557000E.5416800N.	12	1
15.	Mt. Horror track	.561950E.5451800N.	4	2
15.	Mt. Horror track	.562800E.5451875N.	4	2
16.	Mt. Paris Dam Road	.567000E.5439000N.	10	1
16.	Cascade River	.569850E.5439400N.	12	1
17.	Bells Hill	.569400E.5435900N.	18	2
18.	Mt. Victoria	.570000E.5427600N.	1	3
19.	Mutual Road	.570800E.5439500N.	26	1
19.	Mutual Road	.571950E.5439200N.	26	1
19.	Mutual Road	.572150E.5439100N.	16	1
20.	Maa Louey Road	.574350E.5435150N.	10	3
20.	Maa Louey Road	.574450E.5435150N.	10	3
20.	Minnie Jessop Road	.573900E.5436400N.	21	3
21.	Frome Road	.577300E.5440700N.	20	3
23.	Weldborough Pass	.579000E.5436200N.	9	3
25.	Lottah	.585200E.5436100N.	9	4
26.	Goulds Country	.588000E.5434000N.	25	4
27.	Platts Look Out	.590100E.5437600N.	17	4
28.	Goulds Country	.591500E.5434700N.	5	1

(see Table Three for Collector identity)

TABLE 2

List of localities Recorded or Advised.

No.	Locality	Grid Reference	Collector
2.	Mt. Arthur	.525000E.5430900N.	8
4.	Sideling Range	.535700E.5433050N.	3
6.	Mackenzie Rivulet	.546100E.5432900N.	3
8.	Hogarth River	.550000E.5432000N.	2
10.	Ben Ridge Road	.553000E.5421300N.	13
11.	Ringarooma Valley	.553000E.5425000N.	6
12.	Kamona	.556500E.5447300N	26
12.	Kamona	.553800E.5446600N	26
14.	Paradise Plain	.570200E.5426200N.	27
18.	Mt. Victoria	.570200E.5426200N.	18
18.	Mt. Victoria	.570600E.5425400N.	21
21.	Frome Road	.577000E.5443000N.	26
22.	St. Columba Falls	.577600E.5425000N.	28
24.	Evercreach Reserve	.581450E.5415350N.	19
29.	Nunamara	.531200E.5414200N.	22
30.	Scottsdale	.410101S.1470311E.	7

TABLE 3

List of Collectors

No.	Name	Collection Date Locality No.
1.	D. Barrett	27-v-1985 (18).
2.	A. T. Blake	10-xi-1984 (8).
3.	P. Duckworth	12-iv-1986 (4).
4.	P. Duckworth, R. M. Smith	20-i-1984 (15).
5.	M. Fitch	14-viii-1985 (28).
6.	R. C. Gunn	October 1848 (11).
7.	C. Hedley	1890 ? (30).
8.	Launceston Junior Naturalists	1971 (2)
9.	R. C. Kershaw	18-v-1955 (23), -ix-1970 (25), 9-1-1971 (2). 13-2-1971 (2).
10.	R. C. & W. M. Kershaw	19-1-1985 (3), 4-v-1985 (16) (20).
11.	R. C. & W. M. Kershaw, H. P. Morton	5-x-1986 (9) (11).
12.	R. C. Kershaw, B. J. Smith	16-ix-1985 (16).
13.	R. Kershaw, M. Jessup, R. Mesibov, B. Smith	17-ii-1984 (7) (10).
14.	R. Kershaw, B. Smith, M. Smith	18-ix-1985 (13), 19-ix-1985 (13).
15.	R. & W. Kershaw, H. Morton, B. Smith	9-x-1986 (6).
16.	R. Kershaw, V. Harper, B. Smith M. Stranger	16-ix-1985 (19).
17.	D. Lewis	10-xii-1984 (27).
18.	R. Mesibov	23-xi-1983 (17), 25-xi-1983 (4).
19.	M. Miller	3-xii-1984 (24).
20.	D. Mountney, P. Willoughby	17-xii-1986 (21).
21.	R. Murray	30-x-1985 (20), 17-xi-1985 (18).
22.	P. O. Keefe	14-ix-1987 (29).
23.	C. Reid	April 1984 (5).
24.	M. Shea	15-iii-1980 (3).
25.	Augustus Simson	Before 1900 (26).
26.	R. M. Smith	-iii-1984 (19), 12-iv-1984 (12), 8-x-1984 (12). 22-xi-1984 (21), 26-ii-1985 (18).
27.	M. Stranger	31-x-1984 (14).
28.	Tasmanian Museum	(22).

REFERENCES

Bargman, H. E. 1930. The morphology of the central nervous system in the Gastropoda Pulmonata. *J. Linn. Soc.* Lond. 37: 1-58.

Bureau of Metereology. 1979. *Climatic Survey Tasmania Region 3 Northern.* Aust. Govt. Publ. Serv., Canberra: 1x + 64pp.

Cox. J. C. 1868. *Monograph of Australian Land Shells.* William Maddock, Sydney: 111 pp.

Dartnall, A. J. & J. A. Dartnall. 1972. Notes on the reproductive anatomy and cytogenetics of some Australian Acavacean molluscs. *Aust. J. Zool.*, 20: 79-81.

Germain, L. 1925. La distribution geographique et l'origine des Mollusques de la famille des Acavides. *C. R. Con. Soc. Savantes 1924, Sci.* 254-268.

Hedley, C. 1891. On the anatomy of some Tasmanian snails. *Proc. Linn. Soc. N.S.W.* vi: 19-26.

Hedley, C. 1892. On the structure and affinities of Panda atomata Gray. *Rec. Aust. Mus.*, 2: 1-6.

Iredale, T. 1937. A basic list of the land Mollusca of Australia 2. *Aust. Zool.*, 9 (1): 1-39.

Johnston, R. M. 1881. Description of a new species of Helix found fossil in a calcareous deposit at Kent's Group. *Pap. Proc. R. Soc. Tasm.* for 1880: 24.

Kershaw, R. C. 1986. Anatomical notes on the land snail *Bothriembryon* (Pulmonata: Bulimulidae) from South Australia and Western Australia. *Rec. S. Aust. Mus.*, 19 (16): 327-337.

Kershaw, R. C. 1987. Type localities for six species of Tasmanian land molluscs (Pulmonata: Stylommatophora). *Pap. Proc. R. Soc. Tasm.*, 121: 57-68.

McClenaghan, M. P. & Baillie, P. W. 1975. Geological Atlas 1: 250 000 series Sheet SK-55/4. Launceston. *Explan Rept. geol. Surv. Tasm.*, 1-15.

Mead. A. R. 1985. Anatomical studies transfer *Leucotaenius* from Achatinidae to Acavidae (Pulmonata: Sigmurethra). *Arch.Moll.*, 116 (4/6): 137-155.

Petterd, W. F. 1879. *A Monograph of the Land Shells of Tasmania.* Examiner, Launceston. 54 pp.

Pilsbry, H. A. 1890. *Manual of Conchology Series 2.* 6: Academy of Natural Sciences of Philadelphia, Philadelphia.

Pilsbry, H. A. 1894 *Manual of Conchology Series 2.* 9: Academy of Natural Sciences of Philadelphia, Philadelphia.

Reeve, L. 1853a. *Conchologica Iconica.* Species 968 (Mus. Cuming). L. Reeve, London.

Reeve. L. 1853b. Description of a new species of *Helix* from Van Diemens Land. *Proc. Zool. Soc. Lond.*, 1852: 31, pl. xiii.

Smith, B. J. 1967. Correlation between neurosecretory changes and maturation of the reproductive tract of *Arion ater* (Stylommatophora: Arionidae). *Malacologia,* 5(2): 285-298.

Smith, B. J. 1970. Notes on the anatomy of *Victaphanta atramentaria* (Shuttleworth) and *V. compacta* (Cox and Hedley), and the designation of a neotype for *V. atramentaria. J. Malac. Soc. Aust.*, 2 (1): 13-21.

Smith, B. J. & Kershaw, R. C. 1981. *Tasmanian Land & Freshwater* Molluscs. Fauna of Tasmania Handbook No. 5. University of Tasmania, Hobart: 148 pp.

Solem, A. 1972. Malacological applications of scanning electron microscopy. Radular structure and functioning. *The Veliger* 14 (4): 327-336.

Solem, A. 1978. *Classification of the land Mollusca.* Chapter 2., pp 49-97 in V. Fretter & J. Peake (eds.) Pulmonates Volume 2A. Academic Press, London: 540 pp.

Van Mol, J—J. 1967. Etude morphologique et phylogenetique du ganglion cerebroide des Gasteropodes Pulmones (Mollusques). *Mem. Acad. Roy. de Belgique* 37 (5): 1-168.

Von Martens, E. 1860. *Die Heliceen nach naturlicher Verwandtschaft systematisch geordnet von Joh. Christ.* Albers. Zweite Ausgabe: pp. 1-312.

Wells, S. M., Pyle, R. M. & Collins, N. M. 1983. *The* IUCN *Invertebrate Red Data Book.* IUCN, Gland, Switzerland: L + 632 pp.

Zilch, A. 1960. Gastropoda: Euthyneura. *In Handbuch der Palaozoologie.* Band 6. Teil 2, Leif, 1-4, 834 pp.

Appendix One
SHELL DIMENSIONS

A. Specimens Dissected.

Loc. Aperture Register
No.Whs . Ht . Diam . H/D . W/D . W/H .Grp. Ht . Diam . No.
9 . 5 . 25 . 21 . 2 . 31 . 1 . 0 . 68 . 0 . 17 . 0 . 25 . 1 . 14 . 1 . 14 . 6 . QVM1987/9/2
19 . 5 . 37 . 22 . 5 . 32 . 0 . 0 . 70 . 0 . 17 . 0 . 24 . 1 . 14 . 2 . 15 . 5 . QVM1987/9/7
20 . 5 . 37 . 24 . 0 . 32 . 6 . 0 . 74 . 0 . 16 . 0 . 22 . 3 . 16 . 0 . - . . QVM1987/9/8
5 . 5 . 5 . 21 . 1 . 30 . 2 . 0 . 70 . 0 . 18 . 0 . 26 . 3 . 16 . 1 . 14 . 3 . QVM1987/9/4
21 . 5 . 25 . 21 . 0 . 32 . 0 . 0 . 66 . 0 . 16 . 0 . 25 . 3 . 14 . 2 . 15 . 4 . QVM1987/9/9
21 . 5 . 25 . 23 . 2 . 29 . 1 . 0 . 80 . 0 . 18 . 0 . 25 . 3 . 12 . 6 . 14 . 0 . QVM1987/9/9
18 . 5 . 12 . 19 . 6 . 28 . 7 . 0 . 68 . 0 . 18 . 0 . 26 . 3 . 14 . 3 . 13 . 7 . QVM1987/9/10

3. Shell not seen. . QVM1987/9/3
19. Shell damaged. . QVM1987/9/5
19. Shell damaged. . QVM1987/9/6

B. Vouchers.

1 . 5 . 5 . 24 . 4 . 34 . 8 . 0 . 70 . 0 . 16 . 0 . 23 . 1 . 16 . 4 . 14 . 0 . QVM1987/9/12
1 . 5 . 25 . 21 . 2 . 31 . 1 . 0 . 68 . 0 . 17 . 0 . 25 . 1 . 14 . 3 . 14 . 6 . QVM1987/9/2
1 . 5 . 25 . 21 . 4 . 28 . 1 . 0 . 76 . 0 . 19 . 0 . 25 . 1 . 13 . 1 . 13 . 0 . TM E17227
1 . 5 . 25 . 20 . 9 . 28 . 0 . 0 . 75 . 0 . 17 . 0 . 25 . 1 . 13 . 5 . 13 . 7 . AM C153596
1 . 4 . 62 . 17 . 4 . 25 . 5 . 0 . 86 . 0 . 27 . 1 . 12 . 1 . 12 . 1 . 12 . 3 . NMV F53269

C. Group One Means. (Adults) Umbilicus/D. No. Shells.
1 . 5 . 25 . 21 . 4 . 31 . 0 . 0 . 69 . 0 . 17 . 0 . 25 . 20.7% . 28 .
. 5 . 37 . 21 . 7 . 30 . 8 . 0 . 70 . 0 . 17 . 0 . 25 . 20.3% . 8 .
. 5 . 5 . 23 . 1 . 32 . 9 . 0 . 70 . 0 . 17 . 0 . 24 . 24.7% . 22 .
. 5 . 62 . 23 . 7 . 31 . 3 . 0 . 76 . 0 . 18 . 0 . 24 . – . 5 .
. 5 . 75 . 22 . 5 . 31 . 7 . 0 . 71 . 0 . 17 . 0 . 25 . – . 3 .
Average . 22 . 5 . 31 . 7 . 0 . 71 . 0 . 17 . 0 . 25 . 21.9% . 66 .

D . Group Two Means
2 . 5 . 37 . 22 . 5 . 29 . 8 . 0 . 76 . 0 . 18 . 0 . 24 . 26.8% . 1 .
. 5 . 5 . 21 . 0 . 29 . 5 . 0 . 71 . 0 . 19 . 0 . 27 . 23.2% . 4 .
. 5 . 62 . 21 . 4 . 29 . 9 . 0 . 71 . 0 . 19 . 0 . 26 . 25.7% . 2 .
. 5 . 75 . 21 . 5 . 31 . 5 . 0 . 68 . 0 . 18 . 0 . 27 . – . 1 .
Average . 21 . 6 . 30 . 2 . 0 . 71 . 0 . 18 . 0 . 26 . 25.2% . 8 .

Group Three Means
3 . 5 . 25 . 22 . 1 . 30 . 6 . 0 . 72 . 0 . 17 . 0 . 24 . – . 3 .
. 5 . 5 . 22 . 1 . 31 . 1 . 0 . 71 . 0 . 17 . 0 . 25 . – . 2 .
. 5 . 62 . 22 . 7 . 33 . 6 . 0 . 68 . 0 . 17 . 0 . 25 . – . 1 .
. 5 . 75 . 23 . 9 . 32 . 9 . 0 . 73 . 0 . 17 . 0 . 24 . 22.8% . 1 .
Average . 22 . 7 . 32 . 0 . 0 . 71 . 0 . 17 . 0 . 24 . – . 7 .

Group Four Means
4 . 5 . 25 . 20 . 2 . 31 . 6 . 0 . 64 . 0 . 16 . 0 . 26 . 20.5% . 2 .

List of Abbreviations

A—	anus
Ao—	aorta
Bd—	Bursa duct
Bm—	buccal mass
Bp—	Bursa duct pore
Brn—	Buccal retractor nerve
Ce—	cerebral commissure
Cg—	cerebral ganglion
D—	diverticulum
E—	prostate
Fm—	flank muscle
Fo—	free oviduct
Ga—	genital atrium
Hd—	hermaphrodite duct
I—	intestine
K—	kidney
Ln—	labial nerve
Ltn—	labial tentacle nerves
Lv—	main pulmonary vein
Mo—	penis
O—	oesophagus
Ot—	ocular tentacle
Or—	ocular tentacle muscle
Pec—	pedal commissure
Pic—	pleural commissure
Pn—	penial nerve
Rm—	penial retractor muscle
Sa—	salivary gland
Sj—	Bursa-vagina junction
U—	primary ureter
Un—	uterine nerves
Va—	vagina
Ve—	ventricle
Vn—	visceral nerves
.Ag—	albumen gland
.Au—	auricle
.Bg—	buccal ganglia
.Bn—	buccal nerves
.Br—	buccal retractor
.Ca—	carrefour region
.Cea—	cephallic artery
.Cm—	columellar muscle
.Dg—	digestive gland
.F—	foot
.Fn—	flank nerves
.G—	gonopore
.H—	pericardium
.Hg—	ovotestis
.J—	Jaw
.L—	lung
.Lt—	labial tentacle
.Lun—	lung nerve
.Md—	male duct
.Mp—	male duct pore
.On—	optic nerve
.Otn—	ocular tentacle nerve
.Pa—	parietal ganglion
.Peg—	pedal ganglion
.Plg—	pleural ganglion
.R—	rectum
.S—	stomach
.San—	Salivary gland nerve
.Sp—	bursa copulatrix
.Ud—	oviduct (uterus)
.Up—	ureter pore
.Vd—	vas deferens
.Vg—	visceral ganglion
.Vp—	vagina pilaster